



MINISTRY OF
RESEARCH, SCIENCE
& TECHNOLOGY

TE MANATŪ PŪTAIAO

Research & Experimental Development

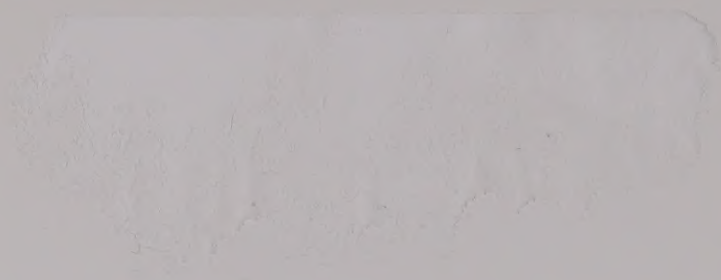
NEW ZEALAND

STATISTICS



ALL SECTORS

1997/98



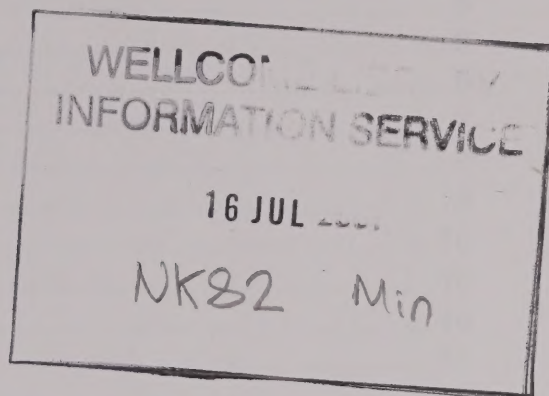
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1997/98



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This document is the report of the joint survey of business and government sector R&D carried out by the Ministry of Research, Science and Technology and Statistics New Zealand, and the Ministry's own survey of R&D in the higher education sector.

Approved for general release

James Buwalda
Chief Executive

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Statistical Summary 1997/98

	NZ	Ref. Countries average	OECD average
1 GDP per capita as % of OECD average (1996)	88	106	100
2 R&D /GDP	1.12	2.16	2.17
excl. defence	1.09	2.07	2
3 R&D per capita population (\$US)	203.3	432.6	420.1
4 Total researchers per 1,000 labour force	4.5	6.6	5.1
5 Government R&D budget as a % of GDP*	0.61	0.83	0.76
excl. defence	0.60	0.77	0.66
6 Government financing of R&D as a % of total R&D	54.1	37.2	32.3
7 Government and university R&D performed as a % of total R&D	71.8	35.4	29.2
8 Government and university R&D performed as a % of GDP	0.80	0.76	0.63
9 Business R&D funding as a % of GDP	0.34	1.19	1.30
10 Business R&D funding as a % of total R&D	31	55.7	61.2
11 Business R&D performed as a % of total R&D	28.2	63.1	68.2
12 Business R&D performed as a % of GDP (BERD/GDP)	0.32	1.43	1.48
13 Scientific publications per 100,000 population, 1995	75	98	52
14 % of foreign ownership of domestic inventions, 1993-95	12.1	14	8.6
15 % of domestic ownership of foreign inventions, 1993-95	7.8	13.7	9
16 % of scientific publications with a foreign co-author, 1995	31	36.8	26.7
17 % of patents with foreign co-inventors, 1993-95	18.8	16.2	9.2
18 Share of high and medium high tech industries in manufacturing exports, 1996	18	48	63
19 Average annual growth rate of exports in high and medium high tech industries, 1990-96	19	11.4	7.5

* In New Zealand's case, this is called the Science Envelope.

Reference countries: Australia, Denmark, Finland, Ireland, Norway, Sweden

EXECUTIVE SUMMARY

The New Zealand research and development (R&D) statistics report is published every two years. The information presented here is based on the national survey of R&D performed in the business, government and university sectors. The aims of this report are to provide comprehensive information on R&D activities in New Zealand, describe the linkages between funders and performers of R&D in New Zealand and show how New Zealand compares with the reference and other OECD countries.

National R&D efforts

- R&D expenditure in New Zealand reached a record high in 1997/98, at an estimated \$1,107.4 million, equivalent to 1.1 percent of GDP. Total R&D expenditure increased on average at 6.2 percent per year from 1990/91 to 1997/98. New Zealand has one of the highest R&D growth rates in the OECD.
- The ratio of total R&D over GDP for New Zealand is still low compared with other OECD and reference countries. The low R&D expenditure relative to GDP in New Zealand is mainly due to low business expenditure on R&D.
- The two major sources of New Zealand's R&D investment are the government and business sectors, accounting for 53 percent and 30 percent of all funds spent on R&D in 1997/98.
- All of the sectors increased their R&D performance in 1997/98. The business, government and university sectors were responsible for carrying out 28.2 percent, 35.3 percent and 36.4 percent of R&D respectively in 1997/98.
- The majority of R&D activities (over 70 percent) are carried out by the government sector and university sectors in New Zealand while in other OECD countries 67 percent of R&D is carried out by the business sector.
- New Zealand spent 12.2 percent of R&D on the society and culture area, followed by information and communication (11.4 percent), health (10.7 percent) and horticultural, arable, food, beverages (8.8 percent). The higher proportion of R&D in the society and culture area is due to the universities' high weighting in this area.
- The total full time equivalent (FTE) R&D staff in New Zealand came to 12,899 in 1997/98. Researchers, technicians and support staff accounted for 64.1 percent, 21.4 percent and 14.7 percent respectively in 1997/98. Of the total, 7,904 (61.2 percent) were male and 4,995 (38.8 percent) were female.
- There were 4.4 R&D research scientists per 1,000 labour force in New Zealand in 1997/98, compared to 5.5 in other OECD countries and 6.7 in the reference countries.

Business sector

- Total business expenditure on R&D (BERD) was estimated at \$312.5 million in 1997/98, or 0.32 percent of GDP. Business R&D has reached a record level since the R&D surveys began in 1990/91.

- BERD as a percentage of GDP increased to 0.32% in 1997/98 from 0.27% in 1995/96. By international standards, the ratio of BERD to GDP in New Zealand has been and remains relatively low.
- The business sector funded 79 percent of the total from their own resources. The remainder came from the Government (8.7 percent) and from abroad (11.2 percent).
- Since 1990, the business sector has shown a shift in its R&D emphasis. More R&D is being performed in the industries producing machinery, equipment, instruments and transport equipment, and in the service sector.
- Compared with other OECD countries, New Zealand's larger companies or firms (employing 1000 or more) spend much less on R&D while small and medium sized firms (employing less than 100) account for a larger proportion of R&D.
- New Zealand's R&D expenditure in the high tech area increased significantly. The proportion of high tech R&D in the manufacturing sector jumped 10.4 percentage points from 1995/96 to 1997/98.
- R&D expenditure as a proportion of sales of manufactured products was 0.37 percent in 1997/98, compared to 6.6 percent in OECD countries.

Government sector

- According to the survey, total Government R&D funding reached \$561.8 million in 1997/98, equivalent to 0.57 percent of GDP. Government funds continue to be a major source of R&D financing, accounting for 54 percent of the total R&D investment in New Zealand.
- Health was the largest output area Government funded in 1997/98, followed by horticultural, arable, food and beverages and the society and culture area.
- Expenditure on R&D carried out by the government sector (GOVERD) in New Zealand in 1997/98 was \$391.3 million, equivalent to 0.40 percent of GDP.
- The Crown Research Institutes (CRIs) are the main performers in the government sector, accounting for 86.3 percent of the government R&D activities in 1997/98.
- Most of the funding for government R&D came from government sector itself (79 percent). The remainder was from the business sector and overseas.
- The survey showed that a significant portion of R&D carried out in the government sector continues to be in agricultural sectors.
- R&D staff in the government sector comprised 3,816 FTE in 1997/98. Researchers represented 46.3 percent, technicians 31.7 percent and support staff 22 percent. CRIs comprised 88 percent of R&D staff in the government sector in 1997/98, compared to 91 percent in 1995/96.

Universities

- The total R&D expenditure by New Zealand's universities was estimated at \$403.5 million in 1997/98, equivalent to 0.4 percent of GDP.
- New Zealand's university R&D expenditure as a proportion of gross domestic R&D expenditure is relatively high in international terms.

- The major source of R&D funds is Government (60 percent), followed by University's own funds including student fees and other income (28.7 percent).
- By discipline, thirty four percent of R&D carried out by universities was in the natural sciences, technology and engineering, 39.2 percent in the social sciences and humanities. Medical and health sciences accounted for 23.3 percent and agriculture 3.8 percent.
- By output area, almost 28 percent of the research undertaken by universities was in the society and culture area, 23.4 percent in health research and 18 percent in the advancement of knowledge.
- Total R&D staff in universities was 6,156 FTE, accounting for 47.7 percent of the total R&D staff in New Zealand. Universities have the highest proportion of full time equivalent researchers compared with the business and government sectors.

Introduction

Research and development (R&D) statistics and indicators are an important instrument of science and technology policy formulation. Many countries publish quantitative overviews of the performance of their science and technology (S&T) system based on R&D statistics.

The New Zealand R&D statistics report is published every two years. The information presented here is based on the national survey of R&D performed in the business, government and university sectors. The aims of this report are to provide comprehensive information of R&D activities in New Zealand, describe the linkages between funders and performers of R&D in New Zealand and show how New Zealand compares with the reference and other OECD countries.

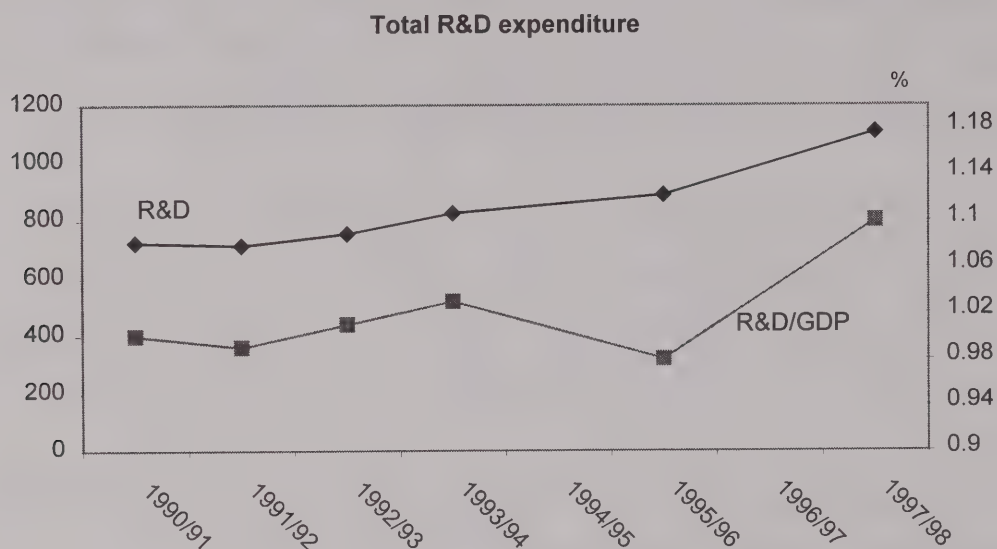
The value of this information on R&D increases the longer the time frame over which it is collected. It is therefore the intention to repeat this survey at least every two years. The Ministry recognises that R&D is only one element of a complex process of knowledge creation, distribution and use. We will therefore continue to develop new science and technology indicators to improve the ability to address S&T policy development and monitoring issues, particular from an outcome focus.

This report is arranged in four main sections. Section one shows overall R&D efforts in New Zealand, and sections two, three and four present R&D activities in the business, government and university sectors respectively.

National R&D efforts

Gross expenditure on R&D (GERD)

R&D expenditure in New Zealand reached a record high in 1997/98, at an estimated \$1,107.4 million, compared to \$889.5 million in 1995/96. Total R&D expenditure increased on average at 6.2 percent per year from 1990/91 to 1997/98. R&D as a percentage of GDP has risen to 1.1 percent in 1997/98.



The ratio of total R&D over GDP for New Zealand is still low compared with other OECD and reference countries. The average level of R&D over GDP is 2.10 percent for OECD countries, and 2.19 percent for the reference countries. The low R&D expenditure relative to GDP in New Zealand is mainly due to low business expenditure on R&D.

GERD by source of funds

The two major sources of New Zealand's R&D investment are the government and business sectors, accounting for 53 percent and 30 percent of all funds spent on R&D in 1997/98. The remaining funds are provided by universities, overseas and non-profit organisations.

GERD by source of funds (\$million)

	1990/91	1991/92	1992/93	1993/94	1995/96	1997/98
Government	436.9	441.8	445.7	451.6	465.0	579.1
Business	212.6	195.9	224.2	279.2	300.0	337.5
Others	75.2	76.8	85.4	94.0	124.3	190.8
Total	724.6	714.5	755.3	824.8	889.3	1,107.4

Compared with other OECD and reference countries, the share of R&D financed by government is higher (50 percent vs 30 percent) while the share of R&D financed by business is lower (30 percent vs 60 percent) in New Zealand.

GERD by sector of performer

As in other countries, R&D activities are surveyed in New Zealand by sector of performers, divided into business, government and university.

All of the sectors increased their R&D performance in 1997/98. The business, government and university sectors were responsible for carrying out 28.2 percent, 35.3 percent and 36.4 percent of R&D respectively in 1997/98.

GERD by performers (\$million)

	1990/91	1991/92	1992/93	1993/94	1995/96	1997/98
Business	204.4	191.7	204.8	247.9	240.3	312.5
Government	318.2	318.7	318.0	343.4	375.7	391.3
Universities	202.0	204.0	232.3	233.5	273.4	403.6
Total	724.6	714.5	755.3	824.8	889.3	1107.4

Compared with other OECD countries, New Zealand's structure of R&D performance is quite different. The majority of R&D activities (67 percent) are carried out by the business sector in other OECD countries while in New Zealand over 70 percent of R&D is carried out by the government sector and university sectors.

Share of R&D performance (1990-1997 average)

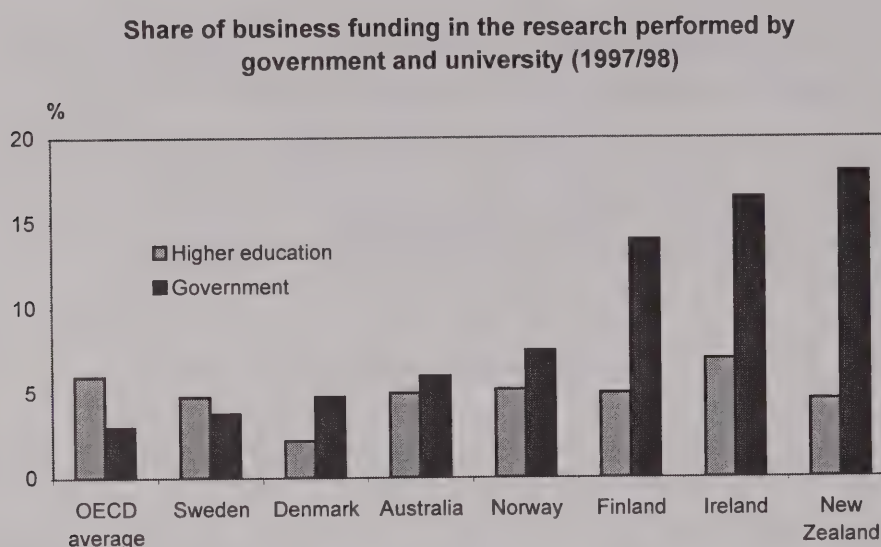
	Business	Government & universities
New Zealand	27.9%	72.1%
Reference countries	60.6%	37.9%
Other OECD countries	67.5%	29.8%

Co-operation between the sectors

Co-operation between the different sectors is one element of a growing trend in co-operation among players in the innovation system. Firms seek access to the fundamental knowledge necessary for their research; universities seek links to commercialise their research and obtain funding; Governments look to alliances that ensure that the economy benefits from public research.

The business sector in New Zealand provided 18.1 percent of the funding for the R&D performed by the government sector and received 8.7 percent of its R&D funds from Government. The business sector provides funding for 4.6 percent of university research.

Compared with other OECD countries, New Zealand has the highest proportion of business funds in the research performed by government. Universities receive an average proportion.



GERD by output areas

The allocation of R&D carried out by the business, government and university sectors to output classes was estimated as follows. It is noted that the three different performing sectors have different emphasis on their R&D activities.

Overall, New Zealand spent 12.2 percent of R&D on the society and culture area, followed by information and communication (11.4 percent), health (10.7 percent) and horticultural, arable, food, beverages (8.8 percent). The higher proportion of R&D in the society and culture area is due to the universities' high weighting in this area.

GERD by output classes (\$000, 1997/98)

	Business	Government	University	Total	%
Animal Industries	35,628	45,986	6,085	87,699	8%
Dairy Industries	58,498	7,991	4,846	71,335	6%
Forage	4,443	27,645	1,701	33,789	3%
Horticultural, Arable, Food, Beverages	18,490	73,430	5,387	97,306	9%
Forest products	16,019	43,188	4,689	63,896	6%
Fisheries and aquaculture	4,411	7,658	1,920	13,989	1%
Manufacturing	37,548	21,784	14,648	73,980	7%
Tourism, Commercial services	2,578	212	9,875	12,664	1%
Information, Communication	85,074	14,331	26,580	125,985	11%
Construction	7,022	1,622	3,417	12,062	1%
Energy	11,907	6,564	6,447	24,919	2%
Transport	3,024	2,103	1,668	6,795	1%
Society and culture	2,743	20,091	112,524	135,358	12%
Earth resources and processes	1,140	18,776	10,443	30,359	3%
Land, fresh water ecology	1,888	20,778	10,381	33,047	3%
Marine, climate and atmosphere	614	64,552	13,783	78,949	7%
Antarctic, defence, other	140	6,968	2,237	9,346	1%
Space, fundamental	0	4,047	72,813	76,860	7%
Health	21,357	3,553	94,107	119,018	11%
Total	312,524	391,279	403,552	1,107,355	100%

Type of R&D expenditure

In 1997/98, labour cost accounted for \$533.9 million (48.2 percent) of the total R&D expenditure, compared to \$445.8 million (50.1 percent) in 1995/96. Other current expenditure at \$479.9 million (43.3 percent) was \$130 million higher than that in 1995/96, while capital expenditure remained at the same level as in 1995/96.

Type of R&D expenditure (\$000, 1997/98)

	Amount	%
Salaries and Wages	533,913	48.2%
Other Current Expenditure	479,954	43.3%
Capital Expenditure	93,510	8.4%
Total	1,107,378	100.0%

National R&D staff

The total FTE R&D staff in New Zealand came to 12,899 in 1997/98. The figures show that the number of FTE R&D staff has been rising steadily in recent years. Researchers, technicians and support staff accounted for 64.1 percent, 21.4 percent

and 14.7 percent respectively in 1997/98. Of the total, 7,904 (61.2 percent) were male and 4,995 (38.8 percent) were female.

Full time equivalent R&D personnel

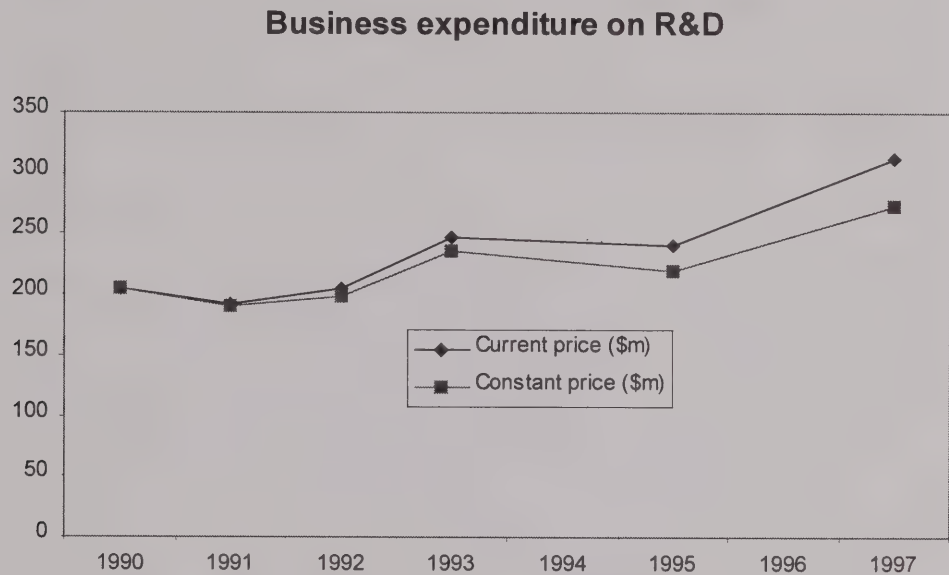
	1990/91	1991/92	1992/93	1993/94	1995/96	1997/98
Researchers	4,893	4,752	5,903	6,200	6,104	8,264
Technicians	2,752	2,796	2,735	2,869	2,838	2,754
Support Staff	1,163	1,157	1,295	1,425	1,606	1,890
Total	8,808	8,706	9,932	10,493	10,547	12,899

There were 4.4 R&D research scientists per 1,000 labour force in New Zealand in 1997/98, compared to 5.5 in other OECD countries and 6.7 in the reference countries.

Business sector

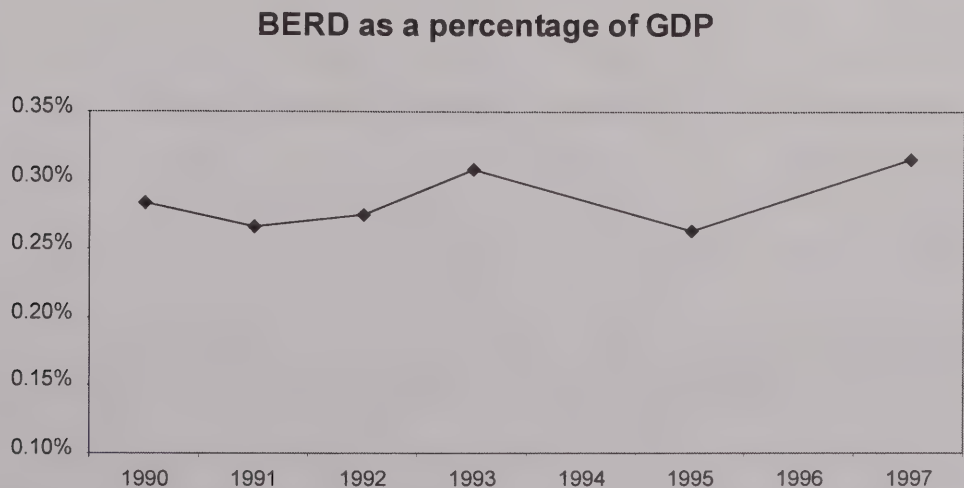
Total business expenditure on R&D (BERD)

Total business expenditure on R&D (BERD) was estimated at \$312.5 million in 1997/98, or 0.32 percent of GDP. Business R&D has reached a record level since the R&D surveys began in 1990/91, up 30% from the previous survey in 1995/96. Real business expenditure on R&D in New Zealand increased by 24 percent over 1995/96.



The ratio of BERD over GDP

New Zealand's BERD as a percentage of GDP increased to 0.32% in 1997/98 from 0.27% in 1995/96. This was the biggest increase since the surveys started and exceeded the 1993/94 level.



By international standards, the ratio of BERD to GDP in New Zealand has been and remains relatively low. In 1997/98, the ratio for New Zealand was 0.32 percent compared with the average ratio for OECD countries of 1.48 percent, for reference countries of 1.43 percent.

International comparisons such as these, however, do not take into account the wide variation of industrial structure among countries. New Zealand's ranking would rise if BERD is adjusted for differences in industrial structure.

BERD/GDP in some selected countries (1997)

Country	%
Sweden	2.67
Finland	1.88
OECD average	1.48
Denmark	1.27
Ireland	0.99
Norway	0.97
Australia	0.80
New Zealand	0.32

Source of funding

The New Zealand business sector funded 79 percent of the total from their own resources (down from 86 percent in 1995/96 and 89 percent in 1993/4). The remainder came from the Government (8.7 percent of the total, up from 7.1 percent in 1995 and 1993) and from abroad (11.2 percent, up from 6 percent in 1995 and 3.4 percent in 1993). The fund from higher education and non-profit organisations combined accounted for 0.8 percent in 1997/98.

BERD by source of funds (\$million)

	1990	1991	1992	1993	1995	1997
Business sector	181.9	168.3	181.6	221.5	207.7	247.8
Government	12.6	13.8	15.7	17.1	16.5	27.1
Higher education	0.1	0.1	0.9	0.4	0.3	2.0
Private non profit	..	0.2	0.2	0.6	2.1	0.6
Abroad	9.8	9.3	6.4	8.3	13.8	35.0
Total	204.4	191.7	204.8	247.9	240.3	312.5

The proportion of BERD funded by Government in New Zealand was among the higher levels in OECD countries in 1997/98. While the amount of government

support for business R&D has been generally falling as a percentage of BERD in most OECD countries, New Zealand's figure has gradually increased.

Percentage of BERD financed by government (1997)

Country	%
Norway	11.9
Sweden	9.5
New Zealand	8.7
Finland	5.6
Denmark	5.1
Ireland	4.5
Australia	2.6

BERD by industry

Total R&D expenditure for the manufacturing sector increased by 11 per cent from 1995/6 to 1997/8 but the proportion of manufacturing R&D over total R&D in the business sector declined by 10 percentage points (68.4 percent in 1995/96 and 58.4 percent in 1997/98). Most R&D investment in the manufacturing sector was concentrated in machinery equipment, instruments & transport equipment, and food, beverages & tobacco, which together accounted for 44 percent of the total for 1997.

R&D expenditure in the service sector, including communications, computer software, insurance and technical consultation services, increased significantly from 1995/96 to 1997/98. Total service R&D reached a record high both in terms of the amounts of money invested and as a proportion of the total business sector.

Overall, since 1990, the business sector has shown a shift in its R&D emphasis. More R&D is being performed in the industries producing machinery equipment, instruments and transport equipment, and in the service sector industry.

BERD by industry (\$million)

	1990	1991	1992	1993	1995	1997
AGRICULTURE	3.6	4.4	6.9	9.1	12.6	11.7
MINING	4.2	4.2	..	1.2	0.7	6.0
MANUFACTURING	124.2	120.2	135.8	156.4	164.5	182.6
Food, Beverages & Tobacco	46.3	44.5	55.0	65.1	59.7	65.1
Textiles, Fur & Leather	16.4	12.6	13.8	14.0	25.2	17.3
Wood, Paper, Printing, Publishing	6.1	3.5	3.0	3.7	7.0	4.3
Petroleum, Coal, Chemicals and Associated Products	15.0	17.3	16.9	15.4	16.0	17.6
Non-Metallic Mineral Products	4.0	4.0	2.1	3.7	2.3	2.0
Basic Metals	1.0	1.4	1.6	3.3	1.6	0.4
Fabricated Metal Products	4.1	3.9	4.0	5.3	3.5	3.7
Machinery Equipment, Instruments & Transport Equipment	29.2	31.7	38.2	44.6	47.0	72.1
Furniture, Other Manufacturing nec	2.2	1.2	1.3	1.4	2.0	0.1
SERVICE SECTOR	72.4	62.8	61.0	81.0	62.5	112.2
TOTAL	204.4	191.7	204.8	247.9	240.3	312.5

BERD by size of business

Businesses employing less than 100 people accounted for 35 percent of the R&D while businesses employing between 100 and 500 people contributed 38 percent of the total. The largest businesses, employing 1000 or more, accounted for 11 percent.

BERD by size of firm

Firm size (by number of FTE)	Percentage of R&D	
	1997/98	1991/92
0-50	24	29
50-100	11	13
100-500	38	39
500-1000	16	19
1000+	11	
Total	100	100

Compared with other OECD countries, New Zealand's larger companies or firms (employing 1000 or more) spend much less on R&D while small and medium sized firms (employing less than 100) account for a larger proportion of R&D.

R&D expenditure by size of firm in selected countries (1997)

Firm size	0-100	100-500	500-1000	1000+
New Zealand	35%	37.9%	16.1%	10.8%
Australia	28%	23%	14%	35%
Denmark	10%	30%	15%	45%
Finland	12%	20%	68% (500+)	
Ireland	32%	57%	11% (500+)	
Norway	26%	29%	45% (500+)	
Sweden	3%	14%	13%	71%

BERD by technology

New Zealand's R&D expenditure in the high tech area increased significantly from 1995/96 to 1997/98. The proportion of high tech R&D in the manufacturing sector jumped 10.4 percentage points from 11.6 percent in 1995/96 to 22 percent in 1997/98. The major contribution to this change came from the electronic equipment industry.

Manufacturing R&D by technology (% , 1997)

	1995	1997
High tech	11.6%	22%
Medium high	24.7%	25%
Medium low	5.0%	4%
Low	58.7%	49%

In comparison with the R&D structure of an average OECD country, New Zealand tends to have a well below average share of high technology industries and a very much above average share of low technology industries.

The structure of R&D in the manufacturing sector (1997)

	High tech	Medium high	Medium low	Low
New Zealand	11.6%	24.7%	5.0%	58.7%
Australia	27.4%	32.3%	29.8%	10.6%
Denmark	40.2%	38.8%	13.7%	7.3%
Finland	43.6%	34.3%	11.2%	10.8%
Ireland	45.9%	22.0%	10.2%	21.9%
Norway	38.3%	29.8%	18.7%	13.2%
Sweden	48.7%	40.7%	5.5%	5.1%
OECD average	43.6%	43.6%	8.7%	4.1%

BERD by type of expenditure

Salaries and wages including redundancy payments consumed 47.5 percent of the \$312.2 million allocated to R&D in 1997/98, compared to 50 percent in 1995/6. Other current expenditure accounted for 44.3 percent, up 4.6 percentage points from 1995/96.

Type of R&D expenditure in business sector (%)

	1995/96	1997/98
Salaries and Wages	50%	47.5%
Other Current Expenditure	39.7%	44.3%
Capital Expenditure (Land and Buildings)	1.9%	0.8%
Capital Expenditure (Other)	8.4%	7.4%
Total	100.0%	100.0%

BERD by output area

BERD can also be allocated to the strategic science output area used for public good science funding. The biggest change in business expenditure on R&D was in the information and communication area. R&D investment in this area increased by over 100 percent from 1995/96 to 1997/98. The proportion of information and communication R&D in total business R&D has also risen from 17 percent to 27 percent.

In other areas, business enterprises targeted \$58.5 million (18.7 percent of the total) at dairy research, \$37.5 million at manufacturing (12 percent), \$35.6 million at animal research (11.4 percent) and \$21.3 million (6.8 percent) at health research. Summary totals for 19 strategic science areas are shown in the table below.

BERD by output area (\$000)

	1995/96		1997/98		
	000s	%	000s	%	% increase
1 Animal Industries	42,162	17.5%	35,628	11.4%	-15.5%
2 Dairy Industries	43,083	17.9%	58,498	18.7%	35.8%
3 Forage	4,583	1.9%	4,443	1.4%	-3.0%
4 Horticultural, Arable, Food, Beverages	15,022	6.3%	18,490	5.9%	23.1%
5 Forest Products	15,158	6.3%	16,019	5.1%	5.7%
6 Fisheries and Aquaculture	1,712	0.7%	4,411	1.4%	157.7%
7 Manufacturing	32,990	13.7%	37,548	12.0%	13.8%
8 Tourism, Commercial Services	2,707	1.1%	2,578	0.8%	-4.8%
9 Information, Communication	40,636	16.9%	85,074	27.2%	109.4%
10 Construction	8,641	3.6%	7,022	2.2%	-18.7%
11 Energy	4,796	2.0%	11,907	3.8%	148.3%
12 Transport	2,906	1.2%	3,024	1.0%	4.0%
13 Society and Culture	3,140	1.3%	2,743	0.9%	-12.7%
14 Earth Resources and Processes	627	0.3%	1,140	0.4%	81.7%
15 Land, Fresh Water Ecology	4,905	2.0%	1,888	0.6%	-61.5%
16 Marine, Climate and Atmosphere	1,180	0.5%	614	0.2%	-48.0%
17 Antarctic, Defence, Other	111	0.0%	140	0.0%	26.6%
18 Space, Fundamental	1	0.0%	-	0.0%	-
19 Health	15,958	6.6%	21,357	6.8%	33.8%
Total	240,319	100.0%	312,524	100.0%	30.0%

R&D intensity by industry

R&D expenditure as a proportion of sales of manufactured products was 0.37 percent in 1997/98, at the same level as it was in 1993/94. In the manufacturing sector, Radio, TV & Communication Equipment and Professional Goods were the most innovative areas, followed by Electrical Machinery and Drugs & Medicines. Wood products & Furniture and Iron & Steel & Non-Ferrous Metals were the least innovative areas in manufacturing in terms of R&D intensities.

R&D intensity in manufactured products (1997/98)

	New Zealand	OECD average
Food, Beverages & Tobacco	0.36%	0.37%
Textiles, Apparel & Leather	0.61%	0.6%
Wood Products & Furniture	0.01%	0.5%
Paper, Paper Products & Printing	0.08%	0.9%
Chemicals excl. Drugs	0.26%	8.5%
Drugs & Medicines	0.98%	2.2%
Petroleum Refineries, Rubber & Plastic	0.22%	4.2%
Non-Metallic Mineral Products	0.13%	1.9%
Iron & Steel & Non-Ferrous Metals	0.02%	2.3%
Metal Products	0.11%	1.3%
Non-Electrical Machinery	0.32%	5.5%
Electrical Machinery	1.30%	8.7%
Radio, TV & Communication Equipment	7.46%	17.1%
Shipbuilding, Aircraft & Other Transport Equipment	0.10%	2.8%
Motor Vehicles	0.05%	12.2%
Professional Goods	5.11%	16.2%
Other Manufacturing, nec	0.05%	2.4%
Total Manufacturing	0.37%	6.6%

In comparison with other OECD countries, over 85 percent of individual industries in New Zealand had a lower R&D intensity than their OECD counterparts. New Zealand's R&D intensity showed a strong weighting towards low tech or medium low tech industries and was much lower in high tech industries.

R&D staff

Human resources devoted to R&D in the business sector have been rising steadily in recent years, reaching 2,927 FTE in 1997/98. Researchers comprised 58 percent of the human resources devoted to R&D, followed by technicians with 28 percent and other supporting staff 14 percent.

R&D staff in the business sector (FTE)

	1990	1991	1992	1993	1995	1997
Researchers	1,495	1,355	1,321	1,507	1,580	1,692
Technicians	792	839	824	896	823	829
Other	315	318	301	378	425	415
Total	2,602	2,512	2,446	2,781	2,828	2,927

Business R&D staff accounted for about 27 percent of the national total in New Zealand, compared to 44 percent in other OECD countries. Scientists and engineers in the business sector made up 26 percent of the national total of scientists and engineers in New Zealand, compared to 38 percent for the OECD country average.

Business R&D staff in New Zealand concentrated on Food, Beverages & Tobacco (22.8 percent), Electronic Equipment (15.3 percent), Scientific Research & Consultation (8 percent) and Business services areas (7.4 percent).

Payments and receipts for technical know-how

Payments for technical know-how were estimated to be \$14.3 million while receipts were estimated to be \$8.4 million in the business sector in 1997/98.

Payments and receipts for technical know how (\$million)

	1990	1991	1992	1993	1995	1997
Receipts	36	36	37.3	36.1	30.7	8.4
Payments	34	27	15.2	13.3	12.4	14.3

Wholesale, Retail Trade & Motor Vehicles etc. Repair was the leading industry making payments for technical know how at \$6.5 million followed by Chemical Products with \$1.1 million. Real Estate, Renting & Business Activities was the leading industry earning receipts for technical know how at \$2.7 million followed by Electrical Machinery with \$2 million.

Overall, payments and receipts for technical know how including use of patents, licences, trademarks, designs, know how and closely related technical services in New Zealand are on a small scale compared with their OECD counterparts.

Government sector

Total Government R&D funding

According to the survey, total Government R&D funding including general university funds (GUF) reached \$561.8 million in 1997/98, equivalent to 0.57 percent of GDP. Government funds continue to be a major source of R&D financing, accounting for 54 percent of the total R&D investment in New Zealand.

Government financing of R&D as a percentage of total R&D is higher but government funding to GDP is lower than the OECD and reference country average.

Government financing of R&D (1997/98)

	Government financed R&D as a % of total R&D	Government financing of R&D as a % of GDP
New Zealand	54.1	0.57
Australia	47.5	0.8
Denmark	39.2	0.7
Finland	35.1	0.9
Ireland	22.6	0.3
Norway	43.5	0.8
Sweden	33	1
OECD average	32.3	0.62

Another way to estimating total Government R&D funding is by Government budget appropriations or outlays for R&D (GBAORD). This essentially involves identifying all the budget items involving R&D and measuring or estimating their R&D content.

Government budget appropriations or outlays for R&D was estimated at \$596 million in New Zealand in 1997/98, or 0.60 percent of GDP

Government R&D funding by output area

Government R&D funding by output area provides an indication of their relative importance in Government's priorities.

The breakdown by output area for Government R&D funding showed that health was the largest output area Government funded in 1997/98, accounting for 11.4 percent of the total Government R&D funding. The next largest area was horticultural, arable, food and beverages which accounted for 11 percent of the total, followed by the society and culture area (10.7 percent).

In terms of the proportion of funding, fundamental research had the biggest increase, followed by fisheries and aquaculture, then manufacturing. The areas with a

decreased share of funding were animal industries and horticultural, arable, food and beverages.

Estimates of Government funding of R&D by output area (1997/98)

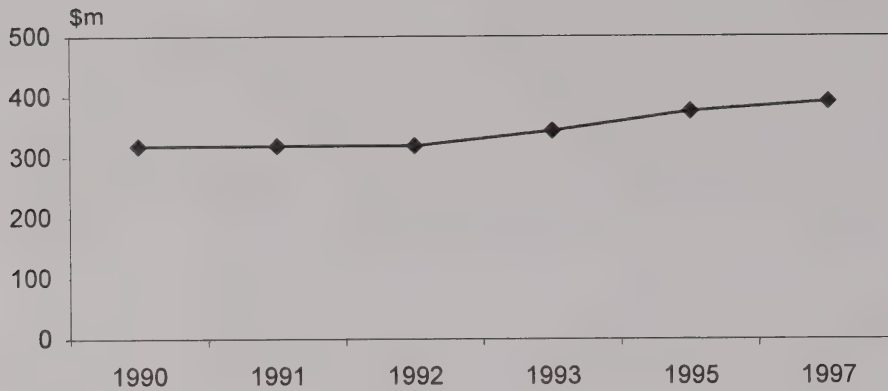
	\$000	%
Animal Industries	47,155	8.4%
Dairy Industries	16,672	3.0%
Forage	25,477	4.5%
Horticultural, Arable, Food, Beverages	61,605	11.0%
Forest Products	30,065	5.4%
Fisheries and Aquaculture	17,713	3.2%
Manufacturing	39,878	7.1%
Tourism, Commercial Services	4,968	0.9%
Information, Communication	21,032	3.7%
Construction	6,397	1.1%
Energy	9,854	1.8%
Transport	2,567	0.5%
Society and Culture	60,009	10.7%
Earth Resources and Processes	23,289	4.1%
Land, Fresh Water Ecology	41,293	7.3%
Marine, Climate and Atmosphere	39,921	7.1%
Antarctic, Defence, Other	3,219	0.6%
Space, Fundamental	46,891	8.3%
Health	63,815	11.4%
Total	561,819	100.0%

R&D carried out in the government sector

Expenditure on R&D carried out by the government sector (GOVERD) in New Zealand in 1997/98 was \$391.3 million, an increase of 4.2 percent compared with 1995/96. GOVERD represented 0.40 percent of GDP, remaining at the same level as in 1995/96.

The Crown Research Institutes (CRIs) are the main performers in the government sector, accounting for 86.3 percent of the government R&D activities in 1997/98.

R&D carried out in the government sector (GOVERD)



R&D performed in the government sector comprised 0.40 percent of GDP in New Zealand in 1997/98, compared with 0.26 percent for the OECD average and 0.28 percent for the reference countries. New Zealand stands out internationally in its ratio of GOVERD over GDP.

GOVERD as a % of GDP	
New Zealand	0.40
Australia	0.40
Finland	0.39
Denmark	0.32
Norway	0.30
OECD average	0.26
Sweden	0.13
Ireland	0.12

GOVERD by source of funding

Most of the funding for government R&D came from government sector itself (79 percent in 1997/98). The bulk of funding (60.2 percent) came from the Foundation for Research, Science and Technology (FRST), which allocates funds from the PGSF. This increased in value by \$17.3 million since 1995/96. The second largest portion of funds for R&D in the government sector was from the New Zealand business sector, representing 18.1 percent in 1997/98. Compared with that in 1995/96, the government R&D funded from the New Zealand business sector increased by \$5.4 million in 1997/98.

In 1997/98, funding from abroad increased by 34 percent from 1995/96.

Source of funds for R&D carried out in the government sector (\$'000)

Source of Funds	1992/93	1993/94	1995/96	1997/98
Own Funds	17,418	25,552	28,814	27,930
Foundation of Research Science and Technology	203,554	210,211	218,806	236,104
Other NZ Central Government Agency	53,834	51,813	48,421	40,316
NZ Local Government	2,720	2,381	4,288	4,304
Tertiary Education Sector	205	136	676	1,111
Business Sector NZ Enterprises	33,404	45,498	65,575	70,961
Funds from Abroad	4,478	4,112	7,134	9,568
Other Sources of Funds	2,408	3,696	1,936	985
Total	318,021	343,339	375,649	391,279

GOVERD by type of expenditure

Labour costs represented 45.9 percent of R&D expenditure in the government sector in 1997/98, compared to 47.7 percent in 1995/96. Other current expenditure in R&D including non-capital purchases of materials, supplies and equipment increased by 5 percentage point while capital expenditure (other) decreased by more than 3 percentage point. Capital expenditure (land and buildings) remained at around 3 percent of R&D expenditure.

Type of R&D expenditure in the government sector

	1995/96	1997/98
Salaries and Wages	47.7%	45.9%
Other Current Expenditure	39.9%	45.1%
Capital Expenditure (Land and Buildings)	3.2%	3.1%
Capital Expenditure (Other)	9.3%	5.9%
TOTAL EXPENDITURE	100.0%	100.0%

GOVERD by output areas

Overall Government R&D effort in output areas remained unchanged in 1997/98. The figures show that a significant portion of R&D carried out in the government sector continues to be in agricultural sectors. Areas in which most R&D expenditure occurred were: Horticultural, arable, food and beverages (18.8 percent); Marine, climate and atmosphere (16.5 percent); Animal industries (11.7 percent); Forest products (11 percent) and Forage (7.1 percent).

GOVERD by output areas

	1995/96		1997/98	
	\$000	%	\$000	%
Animal Industries	50,269	13.4%	45,986	11.8%
Dairy Industries	5,554	1.5%	7,991	2.0%
Forage	32,400	8.6%	27,645	7.1%
Horticultural, Arable, Food, Beverages	70,998	18.9%	73,430	18.8%
Forest Products	35,235	9.4%	43,188	11.0%
Fisheries and Aquaculture	24,541	6.5%	7,658	2.0%
Manufacturing	17,766	4.7%	21,784	5.6%
Tourism, Commercial Services	52	0.0%	212	0.1%
Information, Communication	9,446	2.5%	14,331	3.7%
Construction	2,519	0.7%	1,622	0.4%
Energy	5,482	1.5%	6,564	1.7%
Transport	1,579	0.4%	2,103	0.5%
Society and Culture	15,579	4.1%	20,091	5.1%
Earth Resources and Processes	13,855	3.7%	18,776	4.8%
Land, Fresh Water Ecology	30,145	8.0%	20,778	5.3%
Marine, Climate and Atmosphere	47,219	12.6%	64,552	16.5%
Antarctic, Defence, Other	9,694	2.6%	6,968	1.8%
Space, Fundamental	651	0.2%	4,047	1.0%
Health	2,665	0.7%	3,553	0.9%
Total	375,649	100.0%	391,279	100.0%

R&D staff

Human resources devoted to R&D in the government sector comprised 3,816 FTE in 1997/98. Researchers represented 46.3 percent of R&D staff, followed by technicians with 31.7 percent and support staff 22 percent. Total R&D staff in the government sector decreased by 4.2 percent compared to 1995/96 but research scientists increased by 17.8 percent, reaching the highest level to date.

CRIs comprised 88 percent of R&D staff in the government sector in 1997/98, compared to 91 percent in 1995/96. The number of full time equivalent researchers in the CRIs increased from 1,311 to 1,472. Technicians and support staff reduced by 458 or 19 percent.

Government R&D staff accounted for 35 percent of the national total in New Zealand in 1997/98, compared to 24 percent in other OECD countries.

R&D staff in the government sector (FTE)

	1990	1991	1992	1993	1995	1997
Researchers	1,526	1,525	1,556	1,667	1,498	1,765
Technicians	1,506	1,503	1,414	1,476	1,518	1,211
Support Staff	848	839	781	834	968	840
Total	3,880	3,868	3,751	3,977	3,984	3,816

Payments and receipts for technical know-how

Payments for technical know-how were estimated to be \$0.38 million, down \$2.4 million from 1995/96 while receipts were estimated to be \$2.1 million, up \$0.5 million from 1995/96 in the government sector.

CRIs accounted for 54.1 percent of payments and 37.2 percent of receipts for technical know-how in the government sector in 1997/98.

Payments and receipts for technical know-how (\$000)

	1993	1995	1997
Payments	464	2,828	388
Receipts	3,582	1,600	2,093

Universities

Higher education expenditure on R&D (HERD)

The total R&D expenditure by New Zealand's universities was estimated at \$403.5 million in 1997/98, equivalent to 0.4 percent of GDP. The surveys showed that R&D carried out in university sector as a percentage of both GDP and total R&D increased steadily in the last few years. Part of the large increase in 1998 is due to more comprehensive accounting of capital and overheads

R&D expenditure in universities

	1991	1992	1993	1994	1996	1998
R&D (\$million)	202	204	232.3	233.5	273.4	403.6
% of total R&D	27.9%	28.6%	29.1%	29.3%	30.7%	36.4%

New Zealand's university R&D expenditure as a proportion of gross domestic R&D expenditure is relatively high in international terms, at 30 percent (average) for New Zealand, compared to 20 percent in the OECD.

Source of funds

R&D activities in universities are funded from various sources: GUF or General university funds (from EFTS¹); other funds (including student fees); and contract research income from the business and government sectors, overseas and others. University's other funds including student fees and other income accounted for 28.7 percent of R&D funds. The business and overseas sectors provided 4.6 percent and 3.3 percent of university R&D respectively in 1998.

Source of funds in university R&D

	1996		1998	
	\$million	%	\$million	%
GUF (government)	96.1	35%	144.2	36%
Research contracts (government)	53.4	20%	99.2	25%
Other funds (incl. Student fees)	74.1	27%	115.7	29%
Business	25.6	9%	18.8	5%
Overseas	13.4	5%	13.2	3%
Others	10.9	4%	12.6	3%
Total	273.5	100%	403.5	100%

¹ Each university provided three main categories of income: Equivalent full time student (EFTS) based funding, other funds including student fees and external funds for research contracts. General university funds (GUF) are estimated as the proportion of internally funded research equivalent to the ratio of EFTS funds to EFTS funds plus other funds including student fees.

Field of research

In 1998, about 33.6 percent of R&D carried out by universities was in the natural sciences, technology and engineering, while 39.2 percent went to social sciences and humanities. Medical and health sciences accounted for 23.4 percent and agriculture 3.8 percent.

The major changes in the composition of university R&D between 1996 and 1998 were in the social sciences and humanities, and in medical and health sciences. The proportion of R&D in social sciences and humanities increased 7.3 percentage points while medical and health science decreased 4.1 percentage points from 1996 to 1998.

University R&D by field of study (1998)

	\$000	%
Science - general	3,415	0.8%
Social sciences, humanities and arts - general	37,483	9.3%
Mathematical sciences	13,618	3.4%
Physical sciences	8,155	2.0%
Chemical sciences	11,753	2.9%
Earth sciences	17,385	4.3%
Biological sciences	31,683	7.9%
Information, computing and communication sciences	21,184	5.2%
Engineering and technology	21,251	5.3%
Agricultural, veterinary and environmental	15,237	3.8%
Architecture, urban environment and building	7,203	1.8%
Medical and health sciences	94,333	23.4%
Education	25,307	6.3%
Economics	6,822	1.7%
Commerce, management, tourism and services	15,121	3.7%
Political science and policy studies	8,231	2.0%
Studies in human society	5,719	1.4%
Behavioural and cognitive sciences	6,902	1.7%
Law, justice and law enforcement	8,918	2.2%
Journalism, librarianship and curatorial studies	3,065	0.8%
The arts	11,638	2.9%
Language and culture	15,189	3.8%
History and archaeology	6,736	1.7%
Philosophy and religion	7,204	1.8%
Total	403,552	100.0%

University R&D by output area

In contrast to field of research which is based on academic disciplines, output area is based on the purpose of the R&D used for public science funding.

According to the survey, almost 27.9 percent of the research undertaken by universities is expected to contribute to the society and culture area, 23.3 percent to health research and 18 percent to the advancement of knowledge. The remaining 30 percent spread out across other 16 output areas.

Compared with the business and government sectors, universities have the higher proportion of R&D on basic research and health sciences.

University R&D by output area (\$000, 1998)

1 Animal Industries	6,085	1.5%
2 Dairy Industries	4,846	1.2%
3 Forage	1,701	0.4%
4 Horticultural, Arable, Food, Beverages	5,387	1.3%
5 Forest Products	4,689	1.2%
6 Fisheries and Aquaculture	1,920	0.5%
7 Manufacturing	14,648	3.6%
8 Tourism, Commercial Services	9,875	2.4%
9 Information, Communication	26,580	6.6%
10 Construction	3,417	0.8%
11 Energy	6,447	1.6%
12 Transport	1,668	0.4%
13 Society and Culture	112,524	27.9%
14 Earth Resources and Processes	10,443	2.6%
15 Land, Fresh Water Ecology	10,381	2.6%
16 Marine, Climate and Atmosphere	13,783	3.4%
17 Antarctic, Defence, Other	2,237	0.6%
18 Space, Fundamental	72,813	18.0%
19 Health	94,107	23.3%
Total	403,552	100.0%

Type of expenditure

Wages and salaries accounted for 51 percent of total R&D expenditure in universities in 1998, compared to 54 percent in 1996. Operating expenditure was estimated as 41 percent of the total R&D, up 3 percentage points from 1996. The proportion of capital expenditures was at the same level as in 1996.

Type of expenditure

	1996		1998	
	\$000	%	\$000	%
Wages and salaries	146,756	54%	205,919	51%
Operating expenditure	104,684	38%	164,993	41%
Capital expenditure	22,075	8%	32,642	8%
Total	273,515	100%	403,552	100%

R&D staff

Total R&D staff in universities was estimated at 6,156 full time equivalent (FTE) in 1998, accounting for 47.7 percent of the total R&D staff in New Zealand. Of the total R&D staff in the university sector, 78 percent were academics, 12 percent technicians and 10 percent support staff.

Universities have the highest proportion of full time equivalent researchers compared with the business and government sectors.

R&D staff in universities (FTE, 1998)

	M	F	Total
Researchers	2,701	2,106	4,807
Technicians	321	393	714
Support staff	153	481	635
Total	3,176	2,980	6,156

Annex 1: R&D Survey

A. Methodology

The surveys are carried out according to international definitions and conform to the Frascati Manual of the Organisation for Economic Cooperation and Development (OECD) for the collection of R&D statistics. The results are used to fulfil New Zealand's international obligations to provide R&D statistics.

While remaining consistent with the requirements for international comparability, the Ministry has extended the OECD methodology in some cases to improve the relevance of the information collected to RS&T policy development. This includes asking the business sector to classify its R&D according to the Government's science output areas. This is not done in other countries, but for New Zealand this indicator is an important input into assessing the extent of partnership between government and business.

In the first year of the survey, a stratified random sample of 2,508 firms was surveyed, representing a population of 7,904 firms, research associations and producer boards, in areas of the manufacturing and service sectors which could be expected to engage in R&D. In the second to sixth years, the business sector survey population was based on the response to a brief question on R&D activity sent to the population of about 143,000 firms (all non-government enterprises earning more than \$30,000 in the Statistics New Zealand Annual Frame Update (AFUS) survey).

The sample for 1997/98 survey has been selected using the following criteria (in order of precedence);

1. A listing from MoRST showing Government Departments and Crown entities, as well as private businesses that have received FRST funding for R&D.
2. Those enterprises still 'live' on the BF that reported R&D expenditure in the 1996 survey and also answered positively to the AFUS R&D expenditure question.
3. Those enterprises still 'live' on the BF from ANZSIC division C (manufacturing) that reported more than \$50,000 R&D expenditure in the 1996 survey.
4. Those enterprises still 'live' on the BF from the remaining ANZSIC divisions that reported more than \$150,000 R&D expenditure in the 1996 survey.
5. Those enterprises from ANZSIC divisions C, F, L and M that responded positively to the AFUS R&D expenditure question.
6. Those enterprises from the remaining ANZSIC divisions with 2 or more FTEs that responded positively to the AFUS R&D expenditure question.

Questionnaires and covering information were posted to survey respondents in September 1998. Reminders for firms that had not responded were sent out in late November and telephone follow-ups commenced in December. A response rate of

98.7 percent was achieved from all key firms (more than 100 full time equivalent (FTE)) and 91.8% from other firms employing less than 100 FTE staff.

Imputation for non-respondents was carried out by a method which excluded outliers from the estimation process.

A survey of R&D activities in Universities was undertaken in February 1999 by the Ministry according to OECD standards. A response rate of 100 percent was achieved from all seven universities.

The R&D surveys aim to collect comprehensive R&D statistics from the three sectors so that they can be combined to generate a full picture of R&D. They also aim to establish a methodology for the survey process, which will then be repeated at regular intervals to obtain statistics for release to government organisations, businesses and other users in the community. The statistics are used in the development of science policy, in areas such as the setting of research priorities, funding levels and research strategies, in science education and innovation encouragement schemes. It is hoped that the statistics will also help decision makers in making their R&D investment decisions.

B. Definitions used in the survey

This report follows the convention used in OECD publications of standard abbreviations for the measures of R&D. Only R&D activities, as defined by the OECD, are included in the survey. Consulting and scientific and technological (S&T) services and market research are excluded. The OECD definition of R&D is: "Research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications." Any activity classified as R&D is characterised by originality; it should have investigation as a primary objective, the outcome of which is new knowledge, with or without a specific practical application, or new or improved materials, products, devices, processes or services. R&D ends when work is no longer primarily investigative.

The definition of R&D, in accordance with a change in OECD standards, now includes research into, and development (or substantial modification) of, computer software, such as applications software, new programming languages and new operating systems.

A more comprehensive interpretation of the definition of R&D activity is given in the OECD publication *The Measurement of Scientific and Technical Activities* (the Frascati Manual)

In line with OECD methodology, statistical information is gathered from the providers rather than the funders of research. This is in order to prevent the same research

being reported twice, by both the provider and the funder. Providers are also usually in the best position to determine whether work is R&D or S&T services, and to report on the resources actually expended on research. Information on the sources of funds used by providers is then used to estimate the funding of R&D by each sector.

Most of the tables in this report represent expenditure on R&D carried out in each of the three sectors: business enterprise R&D (BERD), government R&D (GOVERD), and higher education R&D (HERD). That part of university funds for research which comes from Vote Education and is part of the employment contract of academic staff is called "general university funds" or "GUF", as distinct from income from student fees and other sources, including research monies allocated by independent funding bodies, such as the Foundation for Research, Science and Technology or the Health Research Council.

Intramural R&D statistics presented in this publication refer to R&D activity carried out by an organisation on its own behalf or on behalf of other organisations or individuals. Extramural R&D statistics refer to R&D funded by an organisation but carried out by others.

Total funding of R&D by each sector is estimated by subtracting from intramural R&D for that sector the part which is funded from outside the sector and adding any R&D which that sector funds in any other sector.

R&D expenditure includes: capital expenditure on the acquisition of fixed, tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity; current expenditure on wages, salaries and other labour costs, materials, repair, travel, etc., attributable to R&D; and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Human resources devoted to R&D measure the effort of researchers, technicians and other staff directly involved with R&D activity. Overhead staff (e.g. administrative and general services employees, such as personnel officers and cleaners) whose work indirectly supports R&D activity, are excluded from counts of personnel but their costs are included in overheads.

Researchers are those involved with the conception and/or development of new products or processes. They include project managers, directors, scientists and engineers concerned with project content but exclude those concerned with administrative matters.

Technicians are those performing technical tasks in support of R&D activity, normally under the direction and supervision of a researcher. These tasks include performing experiments, maintaining and operating advanced equipment, and computer programming. Other supporting staff are those skilled and unskilled craftspersons, and secretarial, administrative and clerical staff, directly associated with R&D activity.

Technological balance of payments is the collation of those invisible international transactions relating to trade in technical knowledge or know-how. Technical know-how is defined as: existing specialised technical knowledge that is required to produce a successful product or implement a process, e.g. patents; licenses; technical data and information; and scientific, technical or engineering assistance that increases technical knowledge and understanding in the organisation.

Payments for technical know-how exclude other costs, such as overseas travel and subscriptions to periodicals, as well as the cost of computer software and scientific, technical or engineering services that are not aimed at increasing the technical knowledge of the organisation. Receipts for technical know-how exclude contract or commission work carried out on behalf of others.

The business enterprise sector includes all enterprises whose primary activity is the production of goods or services for sale to the general public at a price intended to cover at least the cost of production, and the private non-profit institutions mainly serving them.

The organisational unit for the collection of R&D statistics is the enterprise. An enterprise is defined broadly as the unit comprising all the operations in New Zealand of a single operating legal entity (e.g. company, partnership or sole proprietor).

The vast majority of enterprises included are private businesses. The remainder are public business enterprises mainly engaged in trading or financial activities, research associations funded by levy or grant, producer boards, private non-profit organisations and local authorities.

The survey population covers a wide range of industries from the New Zealand Standard Industrial Classification (NZSIC) 11214 Landscape Planting and Maintenance Services to 95991 Funeral Directors, and between all divisions from Forestry and Logging to Personal and Household Services. The survey covered industries from a total population of 171,676 (taken at February, 1994 from "Business Activity 1995", Statistics New Zealand) government and private sector enterprises (virtually the entire economy, excluding farming enterprises).

For the purposes of R&D statistics, the OECD recommends that research institutes be classified according to the industry they predominantly serve, and this recommendation has been followed in this report. The predominant output area specified by each research association was used as a guide, and supplementary NZSIC codes assigned and used in all tables for the data provided by the research institute.

Each enterprise is classified to the industry in which it mainly operates even though

one or more of its component activity units (factories, shops, etc.) may be classified to other industries.

C. OECD reference countries

Six countries from within the OECD have been identified by the New Zealand Institute of Economic Research (NZIER) as having a number of similar characteristics to New Zealand regarding population, size of the economy, and stage of economic development. These countries, Australia, Denmark, Finland, Ireland, Sweden and Norway, are used in this report as a basis for international comparison of some of the main results and are referred to as the OECD "reference countries".

D. Limitations of the survey data

There are limitations to the level of accuracy that can be expected from an R&D survey. Many respondents do not keep separate account of their R&D expenditure, or they may include R&D with other scientific and technological services, such as consulting. Records may not be kept in the form required for the survey and considerable estimation may be required. Detailed descriptions of what should and should not be included as R&D were provided on the questionnaire form, and phone-in help was available and utilised. However, best estimates were required in many cases. As the survey is repeated, the results can be expected to become more reliable as respondents become more experienced.

The OECD requirement for international comparability means that capital expenditures were requested rather than depreciation. This is in order to avoid comparison of different systems of depreciation internationally. It needs to be borne in mind that large capital expenditures can cause fluctuations in total expenditure from year to year and this can mask a trend or introduce a false trend.

The 1989/90 business enterprise survey was based on a stratified sample; all subsequent surveys except the fourth and seventh have had full coverage. The fourth survey (1992/93) included only top providers and funders for the business enterprise sector, plus rated-up estimates for the rest. The government sector was full coverage. Sampling error will no doubt contribute to the fluctuations noted between the 1992/93 survey and the full coverage surveys, and this must be taken into account when making comparisons. The 1993/94 and 1995/96 surveys were based on full coverage. The 1997/98 survey sample has already been described. There was no survey of R&D carried out in 1994/95 and 1996/97.

Firms are now becoming experienced in responding to the R&D survey and it is expected that consistency of reporting will continue to improve. In the future, improved consistency may mean that data from earlier surveys needs adjusting if long-term trends are to be extrapolated.

Annex 2: RS&T and R&D

Research is the process of advancing knowledge through scientific investigation; Science can be described as the systematic study of the nature and behaviour of the material and physical universe; and Technology is the practical application of this knowledge especially in industry and commerce.

The New Zealand Government's investment in research, science and technology spans several votes. The total investment, referred to as the "science envelope", includes:

- Public Good Research - for example research carried out in tertiary education institutions, the Public Good Science Fund, the Marsden Fund, and Biomedical Research funded by the Health Research Council.
- Practical application of Science and Technology - for example the Technology New Zealand scheme, tourism related research funded through Vote Commerce, operational research by government departments and commissions, and 20 percent of Vote Statistics.
- RS&T System management and development - for example contract management of research funds by agencies such as the Foundation for Research, Science and Technology, the Health Research Council and the Royal Society of New Zealand; monitoring and evaluation; policy advice; public information about science and technology; promotion of science and technology; and fostering of international science and technology relationships.

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D is a term covering three activities: basic research, applied research, and experimental development.

The basic criteria for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of commonly used knowledge and techniques in the area concerned.

R&D is only one RS&T activity. R&D data are usually collected from R&D surveys i.e. performer reported data, while RS&T data are derived from government budgets, based on funders' reports. R&D data are much more internationally comparable than RS&T data.

Annex 3: Science output classes

- 1 Animal Industries
- 2 Dairy Industries
- 3 Forage
- 4 Horticultural, Arable and Other Food, Beverages
- 5 Forest and Forest Products Industries
- 6 Fisheries and Aquaculture Industries
- 7 Manufacturing Industries and Industrial Technologies
- 8 Tourism, Commercial and Other Services
- 9 Information and Communication Networks and Services
- 10 Construction
- 11 Energy
- 12 Transport and Distribution System
- 13 Society and Culture
- 14 Earth Resources and Processes
- 15 Land and Freshwater Ecosystems
- 16 Marine Environments, Climate and Atmosphere
- 17 Antarctic Research

Annex 4: Government sector organisations undertaking and funding R&D, 1997/98

A. Government sector organisation undertaking R&D

Accident Rehabilitation & Compensation Insurance Corporation	Legal Services Board
Animal Control Products Ltd	Lincoln Ventures Ltd
Auckland Museum	Ministry Of Civil Defence
Canterbury Health Ltd	Ministry Of Cultural Affairs
Carter Observatory Board	Ministry Of Justice
Christchurch City Council	Museum Of New Zealand Te Papa Tongarewa
Comnet Technologies Ltd	NZ Council For Educational Research
Counties Manukau Health Ltd	NZ Defence Force
Department Of Conservation	NZ Forest Research Institute Ltd
Department Of Corrections	NZ Historic Places Trust
Department Of Internal Affairs	NZ Institute For Crop & Food Research
Department Of Social Welfare	NZ Pastoral Agriculture Research Institute
Farmpro Systems Ltd	National Institute of Water & Atmospheric Research
Foundation For Research Science & Technology	National Library Of New Zealand
Hawkes Bay Regional Council	Netlink Ltd
Health Care Hawkes Bay Ltd	Otago Regional Council
Industrial Research Ltd	Securities Commission
Institute Of Environmental Science & Research	Southpower Ltd
Institute Of Geological & Nuclear Science	Specialist Education Service
Land Transport Safety Authority Of New Zealand	The Horticulture & Food Research Institute
Landcare Research NZ Ltd	The Treasury

B. Government sector organisations funding R&D

AgVax Developments Limited	Ministry Of Agriculture & Forestry
Alcohol Advisory Council Of New Zealand	Ministry Of Fisheries (MFISH)
Clifton Wool Scour Ltd	Ministry Of Health
Coal Research Association Of (NZ) Inc	NZ Lottery Grants Board
Department For Courts	New Zealand Fish & Game Council
Department Of Labour	Selwyn Plantation Board Ltd
Earthquake Commission	The Agricultural & Marketing Research & & development trust
Foundation For Research Science & Technology	The Royal Society Of NZ
Greenweld Technologies Ltd	Wellington Business Development Board
Health Research Council Of NZ	

Annex 5: New Zealand Standard Industrial Classification
(Grouped for the purposes of R&D statistics)

	Industry	NZSIC codes
1	AGRICULTURE	1
2	MINING	2
3	MANUFACTURING	3
4	Food, Beverages & Tobacco	31
5	Food, Products & Beverages	311-313
6	Tobacco Products	314
7	Textiles, Fur & Leather	32
8	Textiles	321
9	Wearing Apparel & Fur	322-324
10	Leather Products & Footwear	322-324
11	Wood, Paper, Printing, Publishing	331+34+3832
12	Wood & Cork (not Furniture)	331
13	Pulp, Paper & Paper Products	341
14	Publishing, Print. & Repro. of Rec. Media	342+3832
15	Coke, Petroleum, Nuclear Fuel, Chemicals & prod., Rubber & Plastics	35
16	Coke, Ref. Petrol. Prod. & Nucl. Fuel	353+354
17	Chemicals & Chemical Products	351+352
18	Chemicals (less Pharmaceuticals)	351+352 less 3522
19	Pharmaceuticals	3522
20	Rubber & Plastic Products	355+356
21	Non-Metallic Mineral Products	36
22	Basic Metals	37
23	Basic Metals, Ferrous	371
24	Basic Metals, Non-Ferrous	372
25	Fabricated Metal Products	381
26	Machinery Equipment, Instruments & Transport Equipment	38 less 381 & 382
27	Machinery, nec.	382 less 3825+3829
28	Office, Account. & Computing Machinery	3825
29	Electrical Machinery	383 less 3832
30	Electro. Equipment (Radio, TV & Communication.)	3832
31	Electronic Component (incl. Semi-Conduc.)	
32	TV, Radio & Communications Equipment	
33	Instruments, Watches & Clocks	385
34	Motor Vehicles	3843
35	Other Transport Equipment	384+3829
36	Ships	3841
37	Aerospace	3845+3829
38	Other Transport nec.	3842+3844+3849
39	Furniture, Other Manufacturing nec.	332+39
40	Furniture	332

41	Other Manufacturing nec.	39
42	Recycling	NA
43	ELECTRICITY, GAS & WATER SUPPLY	4
44	CONSTRUCTION	5
45	SERVICE SECTOR	6-9
46	Wholesale, Retail, Trade, Motor Vehicle Repair etc.	61+62
47	Hotels & Restaurants	63
48	Transport & Storage	71
49	Communications	72
50	Post	
51	Telecommunications	
52	Finance, Intermediation (inc. Insurance)	81+82
53	Real Estate, Renting & Business Activity	83+932
54	Computer & Related Activities	8323
55	Software Consultancy	
56	Other Computer Services nec.	
57	Research & Development	932
58	Other Business Activities nec.	83
59	Community, Social & Personal Service Activity etc.	9 less 932
60	GRAND TOTAL	1-9

Annex 6: Abbreviations

BERD	Business Enterprise Expenditure on Research and Development
FTE	Full Time Equivalent
GBAORD	Government Budget Appropriations or Outlays for R&D
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GOVERD	Government intramural expenditure on Research and Development
GUF	General University Funds
HERD	Higher education Expenditure on Research and Development
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
RS&T	Research, Science and technology
RSE	R&D Scientists and Engineers, Researchers
TBP	Technology Balance of Payments

